A NOTE ON THE SPIROCHAETES OF TERMITES

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The original observations of spiral organisms in the intestines of termites or "white ants" were made by Leidy (1877), who noted that the gut of *Reticulitermes flavipes* (*"Termes flavipes"*) was distended with material consisting largely of infusorial and other parasites. Of these parasitic forms, Leidy identified three as animal and two as vegetable in character. One of these latter he termed a spirillum, "probably *Spirillum Undula.*"

In a later study of the parasites of termites, Leidy (1881) called the spiral organisms "vibrios" and declared they most nearly resembled the *Vibrio serpens* of Müller. Leidy gave these spiral forms the name *Vibrio termites* and described them as rectilinear and regularly undulant with 3 to 6 waves, commonly stationary and undulating more or less rapidly, but often advancing or receding with variable rapidity, sometimes becoming quiescent. Occasionally they were observed to bend at an obtuse angle while continuing to undulate. The smallest individuals were straight but in motion became bent in the segment of a circle; not infrequently they adhered together by one end, thus forming radiating groups.

Other observations on spiral organisms in termites have been reported by Grassi and Sandias (1893–1894), who recorded spirilla in European termites—*Kalotermes flavicollis* and *Reticulitermes lucifugus* (*"Termes lucifugus"*).

The latest report on organisms of this type in termites has been made by Dobell (1910–1913), who noted them in the course of certain studies on parasitic protozoa from Ceylon.

To these spiral organisms Dobell gave the name *Spirochaeta termitis*, Leidy, as he concluded that the vibrios described by the earlier worker were undoubtedly spirochaetes or treponemata. Dobell observed in his termites two types of spiral organisms, one of which was much larger than the other and the description of which is identical with the *Treponema minei* of Prowazek. These organisms Dobell reported as varying from 20 to 60 micra long by 0.5 micron in width, pointed at both ends, possessing no flagella or crista, and actively motile. When stained by Giemsa stain these organisms take a uniform pink and occasionally exhibit a granular structure.

With these observations in mind, it occurred to the author that it might be of interest to examine other species of termites, as a considerable number of species were immediately available in this laboratory. In this way it was hoped to get a better idea as to the distribution of spiral organisms among the various families of termites and to study more carefully the morphology of such organisms as might be observed. To do this it appeared necessary to examine fresh preparations, made by emulsifying the material contained in the gut of the termites in a saline solution, by dark field illumination and to devise a method of staining that would permit careful study of smear preparations of the same material.

FIG. 1. A REPRESENTATIVE FIELD OF A SMEAR PREPARATION MADE FROM THE STOMACH CONTENTS OF NASUTITERMES MORIO

A similar abundance of spirochaetes will be seen in smears made from all the species examined.

FIG. 2. A LIMITED FIELD OF A PREPARATION OF TERMOPSIS NEVADENSIS

Note the extreme size of some of the spirochaetes seen in this species

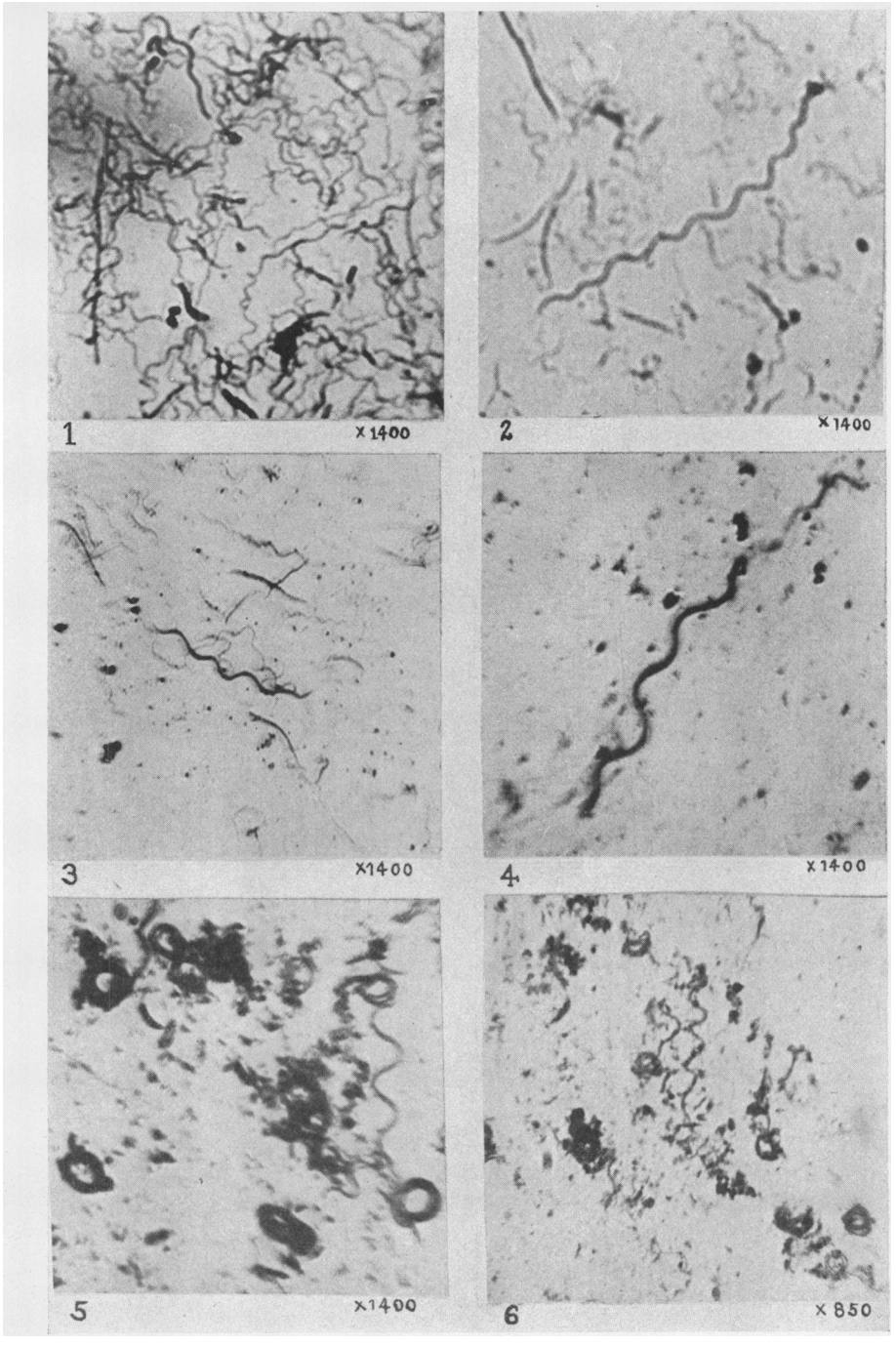
FIG. 3. ANOTHER PREPARATION OF TERMOPSIS NEVADENSIS SHOWING THE SMALLER TYPE OF ORGANISM

FIG. 4. ILLUSTRATION OF THE HEAVILY STAINING TYPE OF ORGANISM FOUND IN CRYPTOTERMES BREVIS

FIG. 5. REPRESENTATIVES OF THE TYPE OF SPIROCHAETAE SEEN ONLY IN KALOTERMES SCHWARZI

Note the occurrence of the circular coils

FIG. 6. ANOTHER FIELD FROM THE SAME PREPARATION AS THAT USED IN THE PRECEDING FIGURE


1
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2
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TABLE 1

Findings in intestinal contents of termites

FAMILY	GENUS	SPECIES	SOURCE	FINDINGS IN INTESTINAL CONTENTS
Kalotermitidae	*Cryptotermes*	*brevis*	Porto Rico	Many heavily staining spirochaetes having 3 to 4 spiral turns, uniformly pointed at both ends and averaging 25 by 1 micra
	Kalotermes	*schwarzi*	Florida	Apparently three types of spirochaetes present. One not very numerous, having 4 spiral turns and averaging 40.5 by 1 micra. A larger number of smaller organisms of an average of 25 by 0.5 micra and with 3 spiral turns. A small number of another heavily staining organism seen only in tightly wound circular coils
		nigriceps	British Guinea	Examined in stained preparations only. Apparently two types of spirochaetes present in considerable numbers varying in size and number of spiral turns
	Termopsis	*angusticollis*	California	Relatively small number of spirochaetes present and these are thin, lightly staining organisms with 2 to 3 spiral curves and averaging 18 by 0.2 micra. Actively motile
		nevadensis	Oregon	Two types of spirochaetes only. One is very abundant and has 4 to 12 spiral turns, while the other is much shorter and has only 4 very fine spirals
Rhinotermitidae	*Leucotermes*	*tenuis*	British Guinea	Stained preparation only observed. Many spirochaetes of varying form noted. Some large and taking the stain heavily, others noticeabiy smaller and staining lightly

Rhinotermitidae.....	*Reticulitermes*	*flavipes*	Maryland	An abundance of large heavy staining organisms, 25 by 0.5 micra in size. The ends are pointed and in dark field preparations occasionally one is seen to be motile
		virginicus	Maryland	Apparently the same organisms as seen in *R. flavipes*, except that the majority are actively motile
		hageni	Maryland	An abundance of spirochaetes indistinguishable from those seen in other species native to Maryland
Termitidae.....	*Nasutitermes*	*morio*	Porto Rico	A few spirochaetes that stain lightly and average 9 by 0.4 microns. Many organisms with four spiral turns having average dimensions of 19 by 0.5 microns and staining heavily

After considerable experimentation with various stains, the following staining technique was worked out and found to give uniform results:

1. Emulsify the gut contents of the termite in a drop of 0.4 per cent saline and expose to the fumes of osmic acid for thirty seconds.
2. Dry in the air or by very gentle heating.
3. Flood the preparation with a 1:5 solution of 50 per cent carbol fuchsin and 50 per cent aniline gentian violet. Stain sixty seconds.
4. Wash in water, dry and examine.

By this method the background is seen to be a light pink and the organisms much darker as they take the gentian violet dye.

Following the above technique for stained preparations, and by the study of supplemental dark field preparations, ten species of termites, representing three of the four families and six genera were examined, with the results shown in table 1.

From this survey it will be seen that all the species of termites examined are infested with spiral organisms of one or another sort. There does seem to be a difference in the flora, however, as there is considerable variation in the size and staining properties of the spiral organisms observed. It might also seem that there is a difference in the flora when we consider the feature of motility, but we are inclined not to stress this as a differential character, as more extensive observations might indicate motility in all cases. In the cases of those organisms seen to be motile, the motion is that typical of spirochaetes in general, although few of these organisms have been observed to move in any direction other than straight forward or backward. In no stained preparation has there been observed any structure similar to a crista or an undulating membrane and thus far no flagella have been demonstrated.

The accompanying photographs depict typical spiral organisms as observed in various species of termites.

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